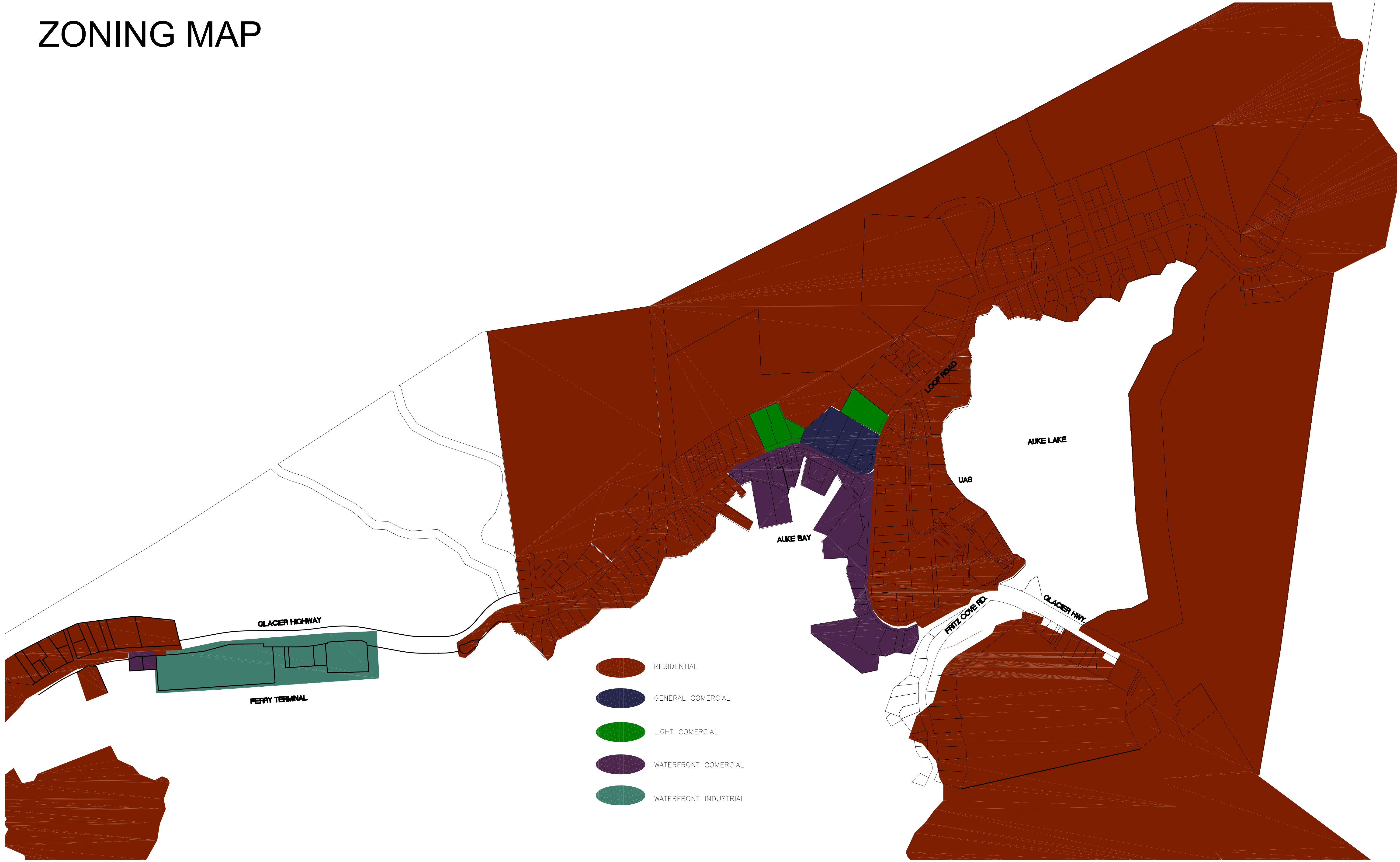
Appendix A.   Zoning

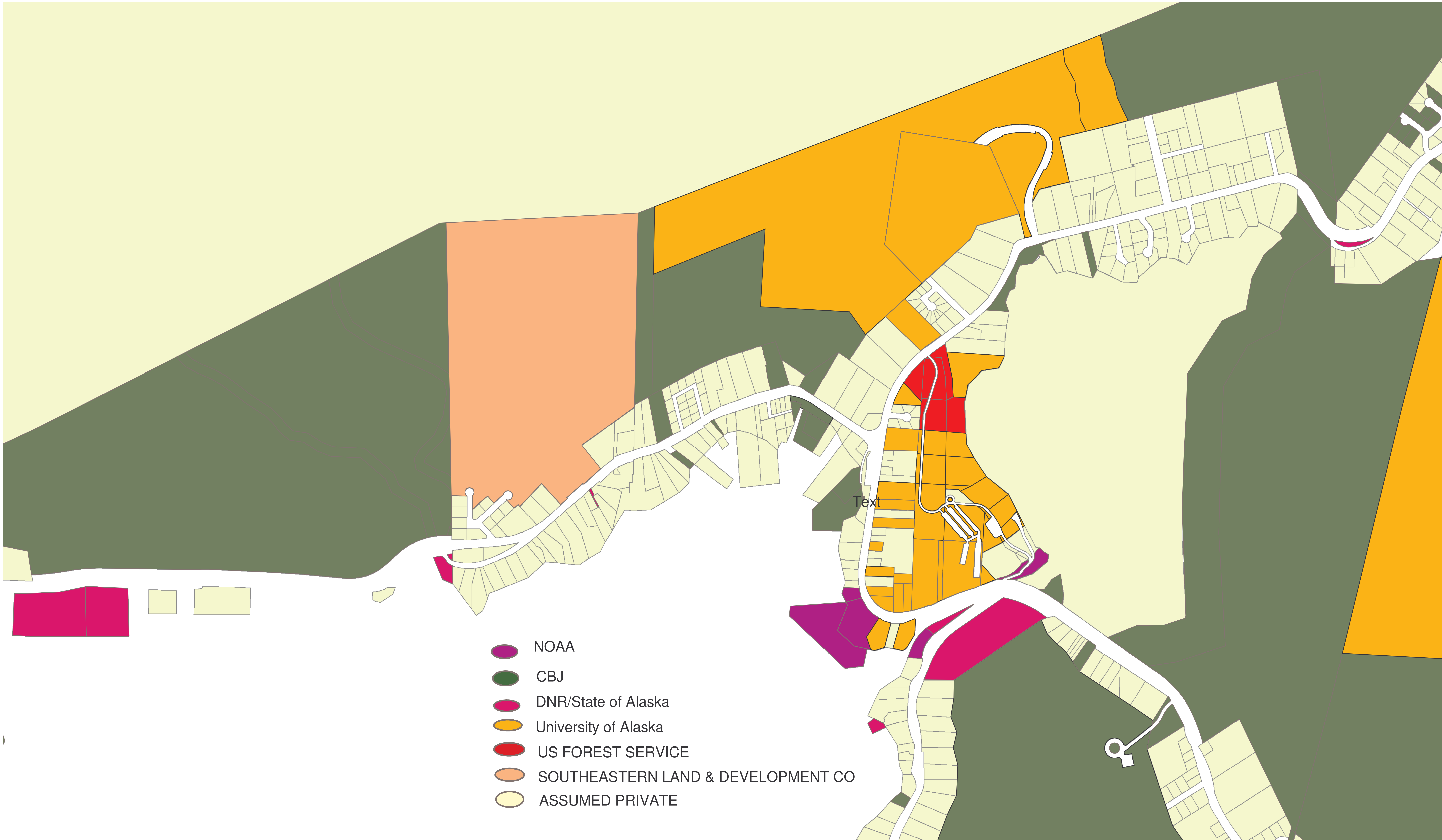
ZONING MAP



GLACIER HIGHWAY
FERRY TERMINAL
AUKE BAY
LOOP ROAD
UAS
AUKE LAKE
FRITZ COVE RD.
GLACIER HWY.
RESIDENTIAL
GENERAL COMERCIAL
LIGHT COMERCIAL
WATERFRONT COMERCIAL
WATERFRONT INDUSTRIAL

Appendix B. Property Ownership

PROPERTY OWNERSHIP MAP



Appendix C. Preliminary Analysis of the Affected Environment

Auke Bay Corridor
Preliminary Analysis of the Affected Environment

Right of Way

The proposed alternatives will need to be evaluated to determine if temporary or permanent easements, land transfers or relocations would be required. The existing right of way width along Glacier Highway varies but is around 100 feet wide. It is adequate for minor widening and realignment.

Social

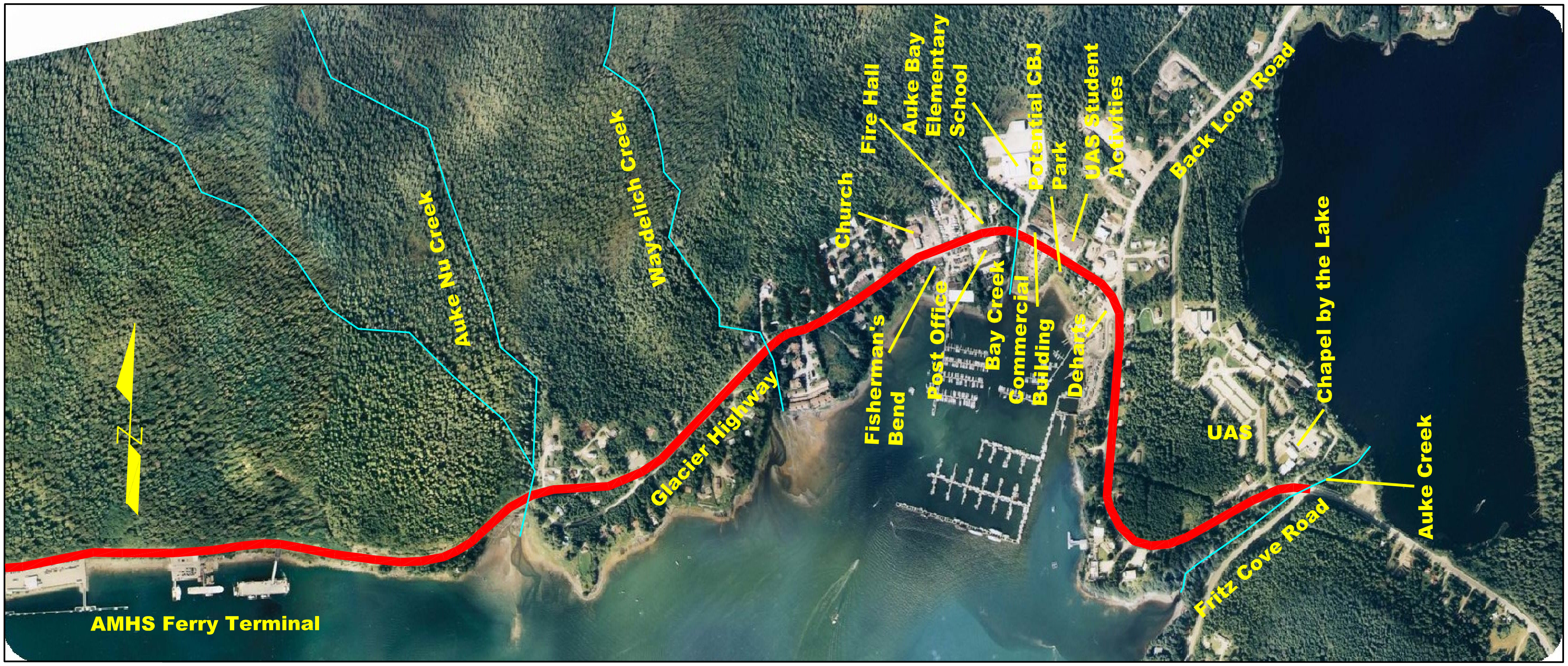
Social impacts include adverse impacts to traffic patterns and accessibility, affects to school districts, recreational areas, churches, businesses and emergency services, and affects to special interest groups, minorities and economically disadvantaged.

The University of Alaska Southeast (UAS) and Auke Bay Elementary School are both located along the project corridor. Parking for the Spaulding Meadows trail is located just off Glacier Highway. Boating, bicycling, hiking and kayaking are popular recreational activities in Auke Bay. Chapel by the Lake and Auke Bay Bible Church are also located along the project corridor. The figure on following page shows the locations of schools, parks, churches, businesses and emergency services.

Economic

Auke Bay supports a variety of public, private, commercial and institutional developments. Fisherman's Bend Marina is built on state leased and private tidelands and has boat stalls, a boatlift, fuel dock, marine repair shop, and both covered and uncovered dry boat storage. Fishermen's Bend also includes an office, boating/fishing supply/convenience/liquor store and auto gas pumps on private uplands. DeHart's Marina is on state leased and private tidelands some of which are filled. The marina includes boat stalls, a boatlift, fuel dock, dry storage, and repair yard. On private uplands there is a small/grocery/convenience/liquor store and auto gas pumps. On the uplands side of Glacier Highway there is a building that houses a bar and restaurant, another restaurant and a hair salon.

Auke Bay Corridor Study
Locations of Social and Economic Importance



Local Land Use and Transportation Plans

According to the December 1993 **Department of Natural Resources, Juneau State Land Plan**, Auke Lake will be managed to support the high public values of the lake including research, water quality, habitat restoration, fisheries management, summer and winter recreation, and landings by aircraft.

According to the July 1996**, City and Borough of Juneau, Juneau Parks and Recreation Comprehensive Plan**, a master plan should be developed for the area around Auke Lake. This report also recommends a trail corridor between UAS student housing and Auke Bay School to be considered for bicycle and skiing use. Furthermore, the report recommends the reservation of a trail corridor between the Auke Bay Elementary School and the Spaulding Meadows trail so Auke Bay school parking lot could provide the necessary overflow parking for the trailhead.

According to the **CBJ Areawide Transportation Plan of July, 2001** the forecast transportation deficiencies relating to Auke Bay are that the Glacier Highway is the only arterial through the area as well as the "main street" of the sub-area. Within a relatively congested area, there is a significant difference in travel speeds between motorized vehicles making local or through trips and pedestrians and bicyclists traveling along or across the highway. This area must be designed to adequately serve pedestrians, bicyclists, and local vehicle trips and through vehicle trips.

Further the plan suggests that improvements for Auke Bay could be traffic calming and the construction of a roundabout or traffic signal at the Back Loop Road intersection. This would integrate the intersection with main street/traffic calming treatments through Auke Bay. Traffic calming treatments used may include landscaping, sidewalks on both sides of the street, access management, pedestrian level lighting, bus pullout/shelter, curb extensions and bicycle lanes. A roundabout could serve as a gateway treatment and a traffic-calming device in the school area. The plan also suggests including pedestrian crossing amenities between University of Alaska campus facilities that are separated by the highway.

The **CBJ 1995 Update to Comprehensive Plan** suggests undertaking transportation improvements within Auke Bay to accommodate additional demand resulting from the construction of the ferry terminal, boat marina, and other facilities, as well as the expansion of the University of Alaska. The plan suggests that the proposed corridor should follow the division between low and medium density residential uses where possible.

The plan also suggests evaluating a corridor realignment of Glacier Highway from its intersection with UAS to Auke Bay and encouraging a new driveway for UAS that avoids the Auke Lake Wayside and minimizes adverse traffic impacts.

Finally the plan suggest requiring sidewalks and bicycle paths or lanes along existing or newly constructed arterial and collector streets, where appropriate, to provide safe and efficient access and recreation and to reduce pedestrian/automobile conflicts.

The **UAS Final Draft Executive Summary Campus Facilities Master Plan, February 2002** presents three site concept options. Option 1 would establish the north entrance off Back Loop Road as the only public entrance to the core area of the campus. The existing entrance from Glacier Highway would be used for access to the Church property and emergency/service access for the campus. Options 2 and 2B would develop a new primary entrance off of Glacier Highway to the south of the existing entrance. A bridge would be required over Auke Creek. Option 3 would realign the existing primary entry drive of Glacier Highway and relocates this road within the campus.

According to **Steve Gilbertson, CBJ Lands and Resources Manager**, there is a proposed subdivision in the Pederson Hill area. The proposal calls for the development of 350 lots. There are also an additional 330 lots on the Mendenhall Peninsula that could be developed.

Cultural Resources

Charles M. Mobley and Associates conducted a cultural resource investigation for NMFS in 1996. In his report he investigated the area near Auke Cape (outside of our study limits), the existing NMFS facility, and an undeveloped parcel southeast of the Fritz Cove Road's intersection with the Glacier Highway, about one-half mile east of the present laboratory.

At the existing NMFS facility site he documented two cannery sites and a midden that he felt would be eligible for the National Register. The two canneries were the Auke Bay Salmon Canning Company and the John L. Carlson Canning Company. The canneries were owned and operated by John L. Carlson and his three sons between the years 1916 and 1923. The historic midden from the John L. Carlson cannery is located on the bluff on the UAS lot immediately adjacent to Auke Creek.

At the parcel southeast of the Fritz Cove Road and Glacier Highway intersection he documented eleven culturally modified trees and the Winn Prospect. The Winn prospect was a deposit located in 1882 at the same time gold was discovered in Montana Basin. John Winn and his father Col. William Winn restaked it in 1909. The father-son team employed ten men for an un-recorded length of time. The rock forming the north end of Pederson Hill is mineralized with other ores besides gold, according to local residents and state assays, but a commercial deposit has not been identified. According to Mobley, the Winn Prospect is not likely to be eligible for inclusion of the National Register.

The photograph below was taken by the USFS about 1920. The red arrows point to the Auke Bay cannery on the left John L. Carlson cannery on the right. The green arrow points to the approximate location of the Winn Prospect.

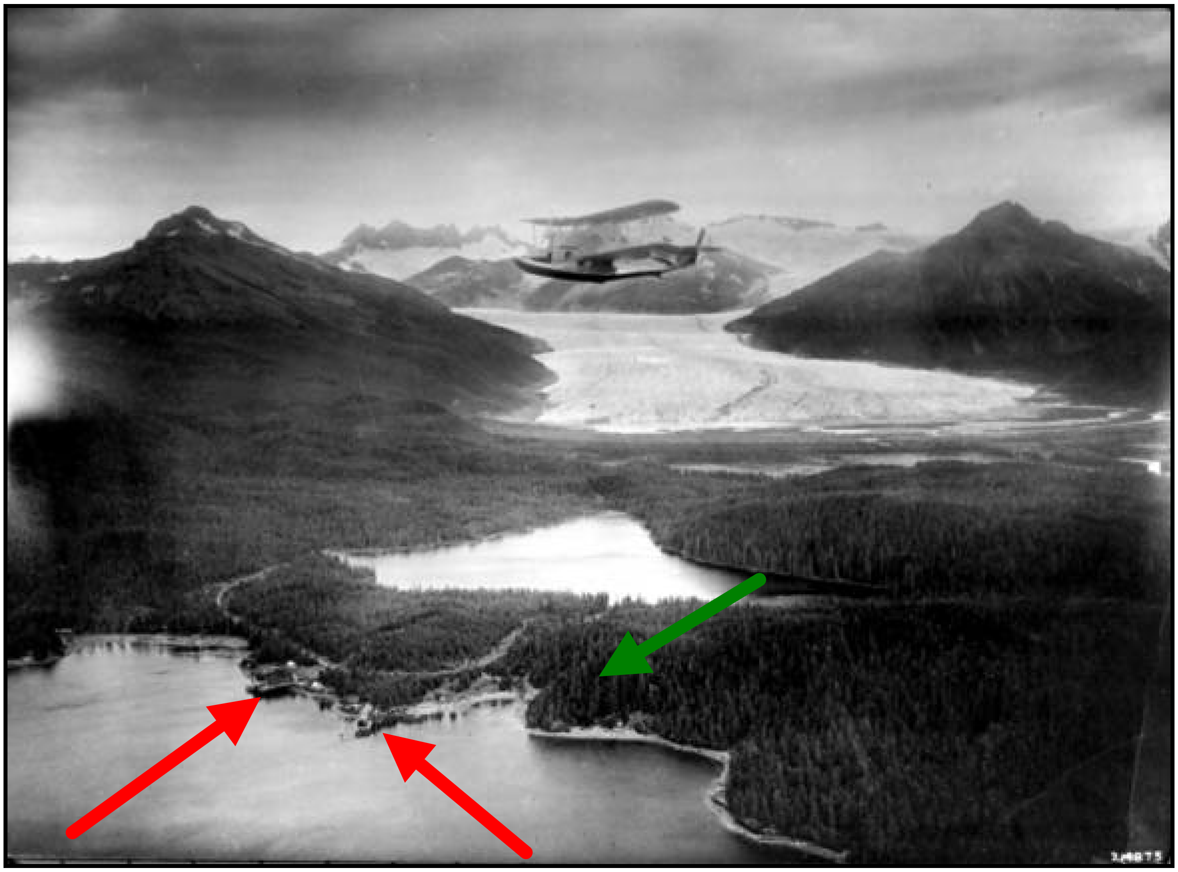


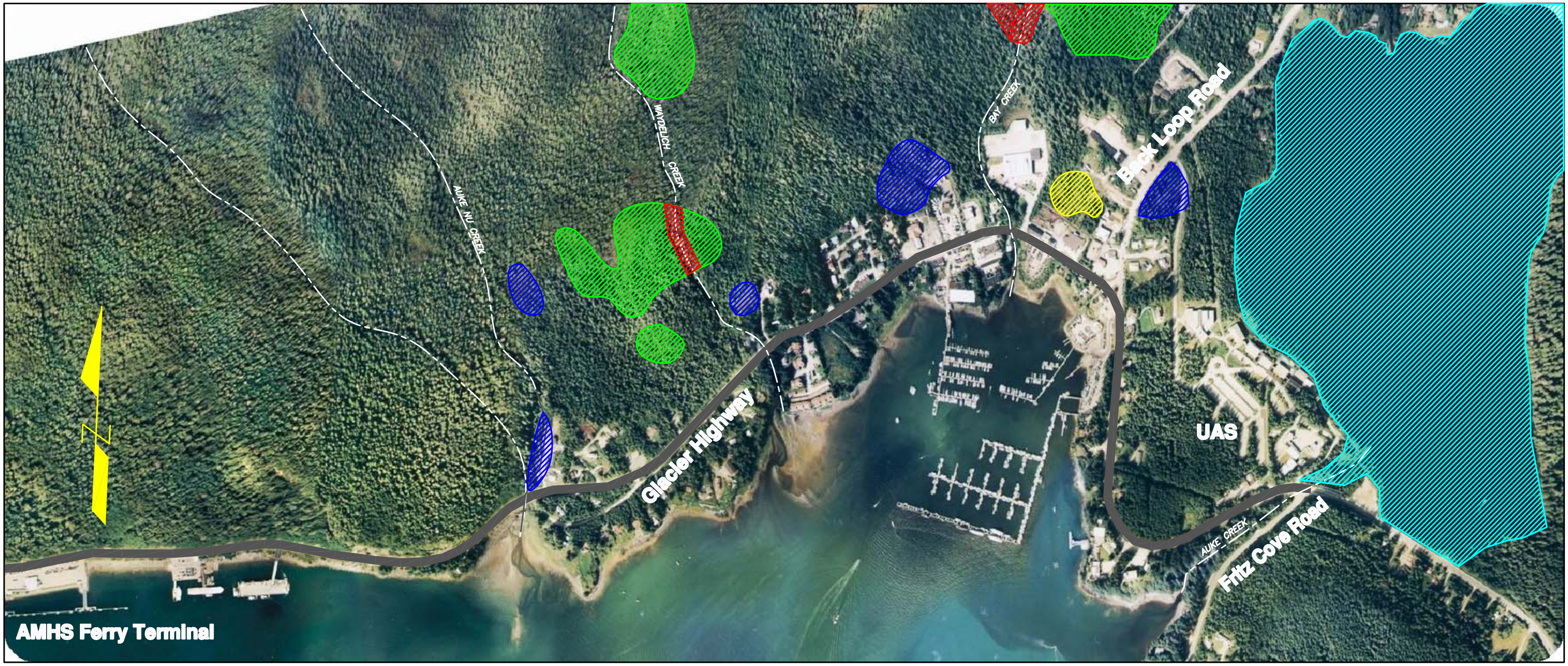
Figure 1 - PCA 207-36-17, Alaska State Library USFS collection

Wetlands

The Juneau Wetlands Management Plan was updated in May 1994. A map from the plan has been reproduced and is presented on the following page. It presents locations of wetlands, wetland categories and stream locations. It does not present Cowardin classification.

Tidelands with dispersed eelgrass beds are also present in the project area. Eelgrass is a marine underwater plant that roots in the sediments of our bays and estuaries, forming meadows in coastal waters. Eelgrass is designated as Essential Fish Habitat under the Magnuson-Stevens Fishery Conservation and Management Act.

The three-dimensional habitat of a healthy eelgrass meadow supports part of the life cycle of herring, mussels, scallops, and crabs. Eelgrass also contributes to the productivity of coastal waters by stabilizing bottom sediments, filtering nutrients and particles out of the water, and by providing sheltered nursery areas for young fish and shellfish. Dead eelgrass decomposes into a detrital "chowder" that is an essential part of the marine food web.



JUNEAU WETLANDS MANAGEMENT PLAN

LEGEND:

A — ONE ENVIRONMENTAL FUNCTION CANNOT BE SUBSTITUTED FOR ANOTHER. MAINTAIN ALL INDIVIDUAL FUNCTIONAL VALUES IN THE WETLAND UNIT.

B — MAINTAIN ALL AGGREGATE FUNCTIONAL VALUES IN THE WETLAND UNIT. ONE ENVIRONMENTAL FUNCTION CAN BE SUBSTITUTED FOR ANOTHER.

C — MAINTAIN OVERALL FUNCTIONAL VALUE ON ROADED SYSTEM. NO NET LOSS OF AGGREGATE VALUE TO REGION.

D — MINIMIZE ADVERSE IMPACTS TO FUNCTIONAL VALUES

EP — ENHANCEMENT POTENTIAL

R — WETLANDS GENERALLY RESTRUCTED DUE TO LAND OWNERSHIP OR MANAGEMENT STATUS.

(s) INDICATES THAT A MORE RESTRICTIVE, CATEGORY A STREAM CORRIDOR

(r) INDICATES THAT A LESS RESTRICTIVE, CATEGORY C, RESIDENTIAL ROAD CORRIDOR DESIGNATION APPLIES TO A PORTION FO THE WETLAND UNIT.

Water Bodies in Project Area

Auke Bay is a large open bay 14 miles north of downtown Juneau supporting a wide variety of public, private, commercial and institutional developments. Auke Bay is a site of heavy recreational and commercial boating use, containing one public and two private marinas and a public boat launch ramp. The bay is also the source of salt water for research conducted at the National Marine Fisheries Service (NMFS) laboratory and UAS research facilities. The bay has high scenic values and provides habitat for aquatic life.

Auke Lake is state-owned. It is about one mile long and ¾ mile wide with a surface area of 175 acres. Auke Lake has high values for habitat and recreation because of the adjoining UAS facilities, five anadromous stream mouths, and public use. The lake is used for fisheries research, sport fishing (including winter ice-fishing), supply water for the hatchery at the mouth of Auke Creek, boating, water skiing, jet skiing, floatplanes, and cross country skiing. The Chapel by the Lake and the UAS campus located on adjacent uplands are tourist destinations partially because of the views of Auke Lake and the Mendenhall Glacier. CBJ has an undeveloped small boat launch and parking area on the south end of the lake off the Glacier Highway. CBJ has established a trailhead at the south end of the lake and a trail along the east shore. Private homes are located along the north and northwest shores. Auke Lake is also an important area for waterfowl habitat and provides resting area for migrating birds.

Auke Creek drains an area of around 3 ½ square miles. The streambed substrate is mostly gravel with some bedrock. A weir has been operated at Auke Creek since 1963. The weir is located above the mean tide line about 400 yards downstream from the outlet of Auke Lake. The weir is cooperatively funded and operated by the Department of Fish and Game, Division of Sport Fish, the National Marine Fisheries Service and the University of Alaska, Fairbanks. The weir is a two-way permanent structure that has the ability to capture all fish returning to and leaving from Auke Lake.

Bay Creek is located approximately 11 miles northwest of Juneau and is crossed by Glacier Highway immediately above tidewater. It enters the northernmost end of Auke Bay between DeHart's and Fishermen's Bend Marinas.

Waydelich Creek flows in a southerly direction for approximately two miles before entering saltwater on the west side of Auke Bay. The stream drains a watershed of approximately one square mile.

Auke Nu Creek drains a watershed of about 1 square mile and flows in a southeasterly direction. A tributary to the southwest joins it before entering a wooden box culvert under Glacier Highway.

Anadromous and Resident Fish Streams

Information in this section is from the Alaska Department of Fish and Game's 1993 Juneau Fish Habitat Assessment and field visits.

Auke Creek

Anadromous Stream Catalog Number: 111-40-10420
Auke Creek flows about 0.3 miles from Auke Lake to salt water in Auke Bay. Auke Creek has runs of coho, pink, chum and sockeye salmon, Dolly Varden, and cutthroat and rainbow trout. Auke Creek provides the primary spawning habitat in the Auke Lake drainage. Most salmon spawning is known to occur in the lower 2000 feet of the stream. Dolly Varden and cutthroat trout use habitat further upstream.

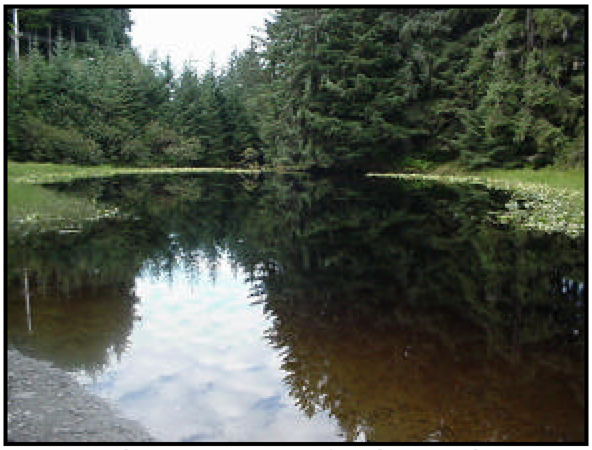


Figure 2 – Start of Auke Creek

Figure 3 – Auke Creek leaves Auke Lake

The creek flows under Glacier Highway through three, 6 foot by 6 foot, concrete box culverts 36 feet in length. Gravel, cobbles and riffle boards are present on the bottom of the westernmost box culvert. During the field visits cracks and patched cracks were visible in the concrete.

Figure 4 – Auke Creek entering structure under Glacier Highway

Figure 5 – Auke Creek exiting structure under Glacier Highway

Bay Creek

Anadromous Stream Catalog Number: 111-40-10390

Bay Creek supports both pink and Coho salmon and Dolly Varden. The creek provides spawning habitat for pink salmon in the lower 50 yards of the stream and the intertidal area. The stream has numerous pools, overhanging banks, logs and dense overhead cover which provide excellent habitat for rearing for Coho salmon.

There is currently no development in this tideland area. On the adjacent uplands to the west of Bay Creek are an 18-unit condominium and the Auke Bay Waste Water Treatment Plant. On adjacent tidelands to the east is undeveloped fill on state-leased tidelands. The 1993 Juneau Fish Habitat Assessment recommended an opportunity to improve spawning habitat below Glacier Highway. The enhancement could consist of excavating a pool at the downstream end of the existing highway culvert along with the importation and stabilization of high quality spawning gravel downstream of the pool for approximately 100 feet.

The University of Alaska has agreed to make some improvements to fish passage through the Bay Creek culvert. The work is being done as mitigation for wetlands fills at the proposed UAS/National Guard Joint Use Facility, and is scheduled to be completed this summer. The University will build some step pools below the culvert to help fish get access to the culvert. The culvert will be retrofitted with some baffles to break up flow and retain sediment. The habitat in the reach directly above the culvert is also at a very high gradient, and could benefit from some small step pools to help fish gain access to lower gradient areas farther upstream.

Figure 6 - Bay Creek Draining into Auke Bay

Figure 7 - Bay Creek just before entering culvert under Glacier Highway

Bay Creek flows under Glacier Highway through a 5-foot diameter corrugated metal pipe. There was no gravel in the bottom of the pipe. The culvert has minor amount of rust on the surface. A 2-foot culvert drains directly from an inlet on Glacier Highway into the Bay Creek Culvert. Please refer to Figures 8 and 9 below.

Figure 8 - Bay Creek entering culvert under Glacier Highway

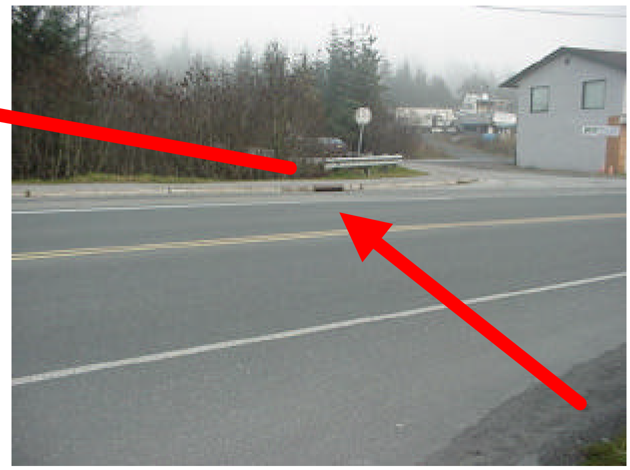


Figure 9 - Glacier Highway Inlet

Figure 10 - Bay Creek exiting culvert under Glacier Highway

Figure 11 - Bay Creek culvert with algae growth on bottom of pipe

Waydelich Creek (pronounced wah-de-lay)

Anadromous Stream Catalog Number: 111-40-10370

Waydelich Creek runs in a southerly direction for about two miles before entering salt water on the west side of Auke Bay. The creek supports pink and chum salmon and Dolly Varden trout. It provides spawning habitat for both species of salmon. This stream has a partial barrier to fish migration at the head of tidewater.

In 1983 a water reservoir for a streamside condominium complex was constructed near the site of a barrier falls. As mitigation for constructing the dams, the developers were required to enhance the spawning area downstream from the dam. The enhanced area has been scoured by heavy stream flows. The Juneau Fish Habitat Assessment recommends re-establishing the spawning area by replacing the spawning substrate that has been washed out.

Figure 12 – Waydelich Creek before entering culvert under Glacier Highway

Figure 13 – Waydelich Creek after exiting culvert under Glacier Highway as seen from Glacier Highway

Waydelich Creek flows under Glacier Highway in a 10-foot diameter corrugated metal pipe culvert. There was no gravel observed in the bottom of the culvert. The inside of the pipe has a minimal amount of surface rust. The culvert is perched. Please refer to Figure 15 below.

Figure 14 – Waydelich Creek entering culvert under Glacier Highway

Figure 15 – Waydelich Creek exiting culvert under Glacier Highway

Auke Nu Creek

Anadromous Stream Catalog Number: 111-40-10350

This stream has provides spawning habitat for pink salmon. Only the east fork of the stream is a catalogued fish stream. There is good intertidal spawning area below Glacier Highway.

Figure 16 - Auke Nu Creek before entering culvert under Glacier Highway

Figure 17 - Auke Nu Creek entering culvert under Glacier Highway

Figure 18 – Auke Nu Creek exiting culvert under Glacier Highway

Figure 19 – Auke Nu Creek exiting culvert under Glacier Highway

Essential Fish Habitat

Essential Fish Habitat is defined as those waters and substrate necessary to fish managed by the North Pacific Fisheries Management Council (NPFMC) for spawning, breeding, feeding or growth to maturity. The Council has primary responsibility for anadromous fish, commercial fish and its prey.

For the purpose of interpreting the definition of essential fish habitat: "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

There are several anadromous fish streams within the project study area. Intertidal and subtidal areas could also be affected. An Essential Fish Habitat Assessment will be required for any alternatives that affect these areas.

Wildlife Resources

The Alaska Department of Fish and Game, Wildlife Conservation Division could not identify any species of special concern in the immediate project area.

Bald Eagles

A location map of eagle trees along the project corridor follows this page. There are four eagle trees (nos. 105,163 202, and 204) located along Glacier Highway. According to Mike Jacobsen of the U.S. Fish and Wildlife Service, tree nos. 54, 180, and 199 are eagle trees with eagles no longer present.

Alaska Coastal Management Program

The project study area is in the jurisdiction of the Juneau Coastal Management Plan. These areas are also categorized as Auke Bay Areas Meriting Special Attention. A consistency review will need to be conducted for the preferred alternative.

Hazardous Waste

There are no documented or suspected areas of hazardous waste with the project study area.

Air Quality Conformity

The project is not within a non-attainment area. The project area is in an area of good circulation. Also the roads within the project area are paved.

Floodplains

There are no floodways delineated in the study area according to the Flood Insurance Study written by FEMA in 1990.

Noise

No noise impacts are anticipated, as this project will not create a new traffic demand. However, if road widening or realignment is proposed, noise impacts will need to be addressed. The locations of sensitive noise receivers (schools, parks, libraries) are presented on the Social and Economic map.

LOCATION OF EAGLE NESTS

Water Quality

There are no impaired water bodies within the project limits. Drinking water is supplied by the city and not obtained within the project limits. Other than the instance of road runoff draining directly off of Glacier Highway and into Bay and Creek, the normal amount of non-point pollution from street traffic is expected in the ara.

References

Adamus Resource Assessment, Inc. and the City and Borough of Juneau, Alaska, Department of Community Development, Juneau Wetlands Functions and Values, September 1987.

Bethers, Munk, Seifert, Alaska Department of Fish and Game, Division of Sport Fish, Juneau Fish Habitat Assessment, March 1993.

City and Borough of Juneau, Juneau Parks and Recreation Comprehensive Plan, July 1996.

City and Borough of Juneau, CBJ Areawide Transportation Plan, July, 2001.

City and Borough of Juneau, Community Development Department, Juneau Wetlands Management Plan and Atlas, February 1997.

Federal Emergency Management Agency, City and Borough of Juneau, Alaska Flood Insurance Study, September 1990.

Mobley, Charles M, Cultural Resource Investigations at Auke Bay, Juneau, Alaska for National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 1996.

State of Alaska, Department of Natural Resources, Juneau State Land Plan, December 1993.

Schrader, Carl, Department of Fish and Game, email, 12/12/02.

University of Alaska, Final Draft Campus Facilities Master Plan, February 2002.

Appendix D. Collision and Conflict Overview Study

Collision Overview Appendix

Using statewide severities for the last 10 years, we can establish a comparative population for each severity type in ABCor on a percentage basis. Figure 1 shows the corridor severity on a percentage basis, the number of collisions of each severity, and the corresponding statewide severity population percentages from 1990 to 2000.

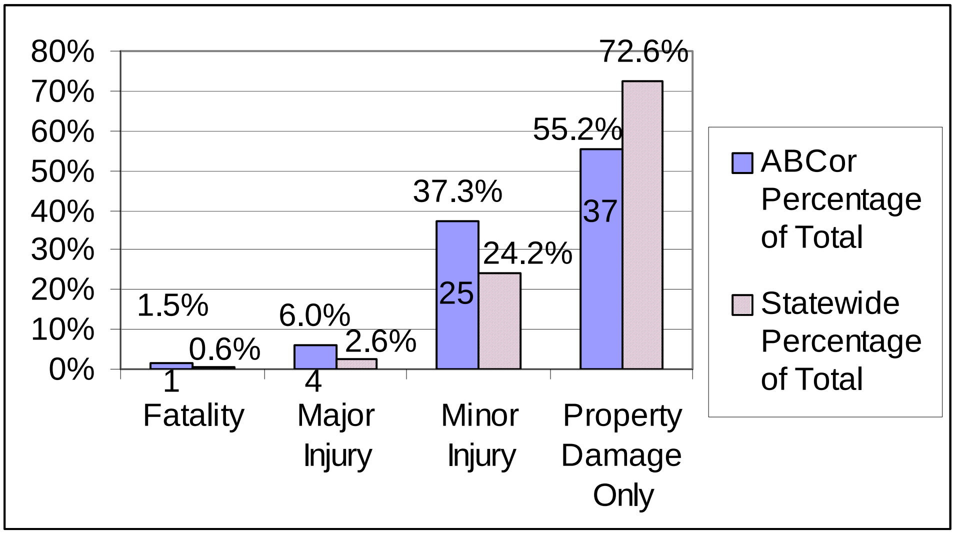


Figure 1 - ABCor Severities (1996 to 2000) and State of Alaska (1990 to 2000) Severities, Percent of Total

Figure 1 presents that the collision severity in ABCor is higher than the statewide populations. Furthermore, statistical significance tests indicate that the Minor Injury collisions are much higher than the population.

It is not surprising that the corridor has more severe collisions than average. All parts of the corridor have higher average and 85th percentile speeds than posted. Also most of the speeds exceed or are close to 45 MPH, which is the break between low speed and high-speed roads (according to our design guides and standards). As severity is theoretically a function of the speed squared, or V^2, so severity increases geometrically, not linearly, with an increase of V. To illustrate further, if a car is involved in an collision in the Waydelich to AMHS Terminal segment at the 85^{th} percentile speed of 56 mph, the increase in speed is only 24% more than the posted speed limit, but the collision, based on energy and force, is 55% more severe.

Most collisions, about 47 (or 70%) occurred in daylight, and this was significantly more of a percentage during the daytime than the comparative statewide population. This leads us to conclude that night collisions are not abnormal and that night lighting or illumination, although always desirable, may not be needed to correct a current collision trend.

We have also examined the collisions as they relate to road surface. We found that the snow and ice surface collisions and dry surface collisions don't vary from the statewide percentages at all. However, the wet surface collisions (20% of total) were about double the statewide population percentage.

In conclusion, we found more injuries than the comparable statewide average, found no relationship between collisions and night condition, and found that there are more wet surface collisions here than in the statewide population percentage.   However, this is the overall snapshot. In the analysis below some of these conclusions don't hold when we examine intersections and roadway segments.

<u>Intersections and Roadway Segments</u>

Roadway segment collision rates and intersection collision rates and the Rate Qualit7y Control Method were used to analyze the project area. For more information about the equations used or the method, please refer to the equations.

The following Tables show the intersection and segment collision types, rates, and average population rates. We also indicate where the Upper Control limit is exceeded.

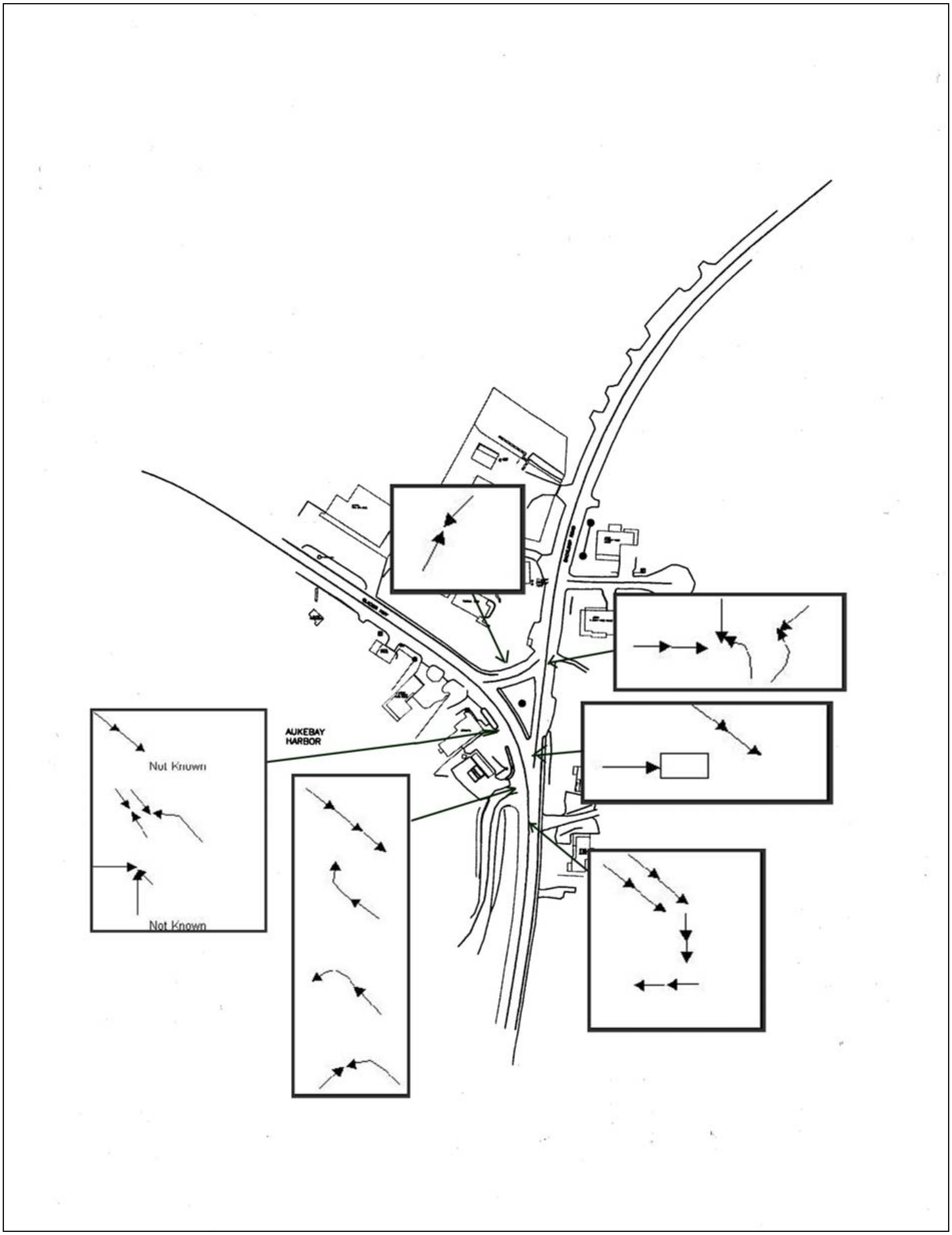
	Guardrail	Head On	Head On Sideswipe	Left Turn	Overtaking Sideswipe	Parked	Rear End	Right Angle	U turn	Int. Total	Collision Rate (Acc/MEV)	Rate >UCL and Significant?	Collision Type(s) Needing Attention?
AMHS Terminal Access and Glacier Highway	1						4	2		7	0.95	No	
Mendenhall Loop Wye, Mendenhall Loop Rd, Harbor, and Glacier Hwy		1	1	2		1	10	3		18	1.19	Yes	Rear-Ends are statistically significant
Fritz Cove, UAS South Access, Glacier Hwy	1		1		1		2	3	1	9	0.44	No	
Mendenhall Loop Rd and UAS North Access							1			1	0.24	No	
Collision Type Totals	2	1	1	2	1	1	17	9	1				

Segment	Ditch	Embankment	Guardrail	Head On	Other	Overturn	Parked	Pedestrian	Rear End	Right Angle	Tree	Segment Total	Collision Rate (Acc/MVM)	Rate >UCL and Significant?	Collision Type(s) Needing Attention?
Glacier Hwy, Ferry to Auk Nu Dr.	4	2		1		2			1			10	2.45	Yes	9 Single Vehicle Loss of Control, 1 Head On.
Glacier Hwy, Auk Nu Dr. to Harbor			2		1	1			2	1		7	0.87	No	
Glacier Hwy, Harbor to Fritz Cove Road			2			1	1		3			7	0.85	No	
Mendenhall Loop Rd, University Drive to UAS North Access	2						2	2		1	1	8	7.98	Yes	2 Pedestrian, 5 Single Vehicle Loss of Control.
Mendenhall Loop Rd, UAS North Access to Glacier Hwy															
Collision Type Totals	6	2	4	1	1	4	3	2	6	2	1				

The only intersection with a significant collision rate is the Mendenhall Wye-Harbor Drive intersection with Glacier Highway. It consists of 5 closely spaced intersections (Mendenhall Loop Road, Mendenhall Wye, Glacier Highway, Harbor Drive and DeHart's Driveway). In this analysis we treat this intersection as a single system because each component has an effect on others.

The following figure shows the collision diagram for the intersection. These are plotted at the location stated on the collision record, which may not be the actual location of the collision. Two of the collisions didn't have enough information to determine the vehicle orientation and are noted as "Not Known". Although the about 40% of the collisions were a Minor Injury Collision, and above the statewide average percentage of 26%, this wasn't significant statistically. We found that the collisions at the intersection are fairly close to the statewide averages for surface conditions and for lighting (actually most happened in daylight).

We think there are three contributing factors to the collisions here. First, the layout is complex. There are many overlapping conflicts, because the vertexes are in close proximity to one another. The skew angles are far flatter than the 90 degrees and it makes visibility of other vehicles and judgment of approach speeds difficult. We see a collision pattern that would be reduced with a left-turn lane on Glacier Highway. We expect that almost all of the rear end collisions are initiated by a vehicle stopped in the throughway waiting for gaps in the oncoming traffic stream. A-left-turn lane would provide the waiting vehicle a refuge space and remove the conflict. Lastly, the approach sight distance is less than desirable, because of the sharp radius and because sight lines are blocked by the abutting development. This in combination of higher than desired approach speeds means that a vehicle wouldn't have time to see, react and stop prior to colliding with a stopped vehicle waiting to slowing down to turn. This especially applies to the southbound approach.



The segment of Glacier Highway between Auke Nu Drive and the Ferry Terminal had 10 collisions in the 5-year study period. It is important to note that an interim safety project has improved drainage in this area. Poor drainage may have contributed to loss of control collisions.

The collision rate indicates that this segment is significantly higher than the population, and that there may be contributing factors other than chance. All of the collisions except one involved a single vehicle running off the road, and the remaining one was a head on collision.

We also find that the severity on the segment, 4 of 10, was significantly higher than the statewide population. If we look at the speeds, we find the speeds are higher than posted (51 MPH average, 56 MPH 85^{th} percentile). Therefore we shouldn't be surprised by the higher severity of collisions.

Nine collisions happened during snow and ice surface conditions, and one occurred during wet pavement conditions. Most collisions happened during daylight hours.

We know that 6 of the 10 collisions occurred near Auke Nu Drive within horizontal and vertical curves that are designed for speeds between 40 MPH to 50 MPH and not the 85^{th} percentile speeds of over 55 MPH. However the road lane and shoulder widths meet standards.

To summarize this area, the collisions are all loss of control collisions, probably due to unsafe speeds on poor road conditions. At least six collisions occurred within horizontal and vertical curves that aren't designed for the prevailing speeds. Lastly, these collisions had a severity that was higher than the population.

University Drive to the UAS entrance on Mendenhall Loop Road had 8 collisions with a high collision rate. Most of the collisions occurred under poor road surface conditions, most at night, and there were more severe collision here on a percentage basis than found in the statewide population. There was one pedestrian fatality here, and a second minor injury pedestrian collision.

This segment has more pedestrian activity than elsewhere because of the student dormitories. The lack of pathways and good crossings probably contribute to these collision patterns. In addition, the vertical curvature may not be adequate for the approach speed.

Intersections and Roadway Segments

Accidents are random events. Given the amount of traffic that passes over a road each year, usually millions of vehicles, the collisions or accidents are very rare, and involved motorists are very small in number. Nonetheless, accidents happen, and its up to us to find if collision pattern is less due to chance and more due to a set of contributing factors.

We try to evaluate the data from two perspectives. We look at the frequency of accidents at a location over the study period, that is the number that occurred during the 5 years of the study. We draw up the accidents in a diagram where we have a visual representation of the accidents. We can often use our engineering judgment (a powerful tool!) to spot clusters or trends that need remediation.

We also like to look at rates. Rate analysis is useful because it defines accidents based on exposure to the number of vehicles using the facility. Roadway segment accident rates are calculated using the following formula:

$$R = \frac{1{,}000{,}000 \times A}{365 \times N \times V \times L} \quad \text{(Eq. 1)}$$

The variables in this equation are:

- R= Accident rate for the roadway section expressed as accidents per million vehicle miles (MVM),
- A= Frequency of accidents in the study period,
- N= Number of years of data,
- V= Traffic volumes per day, the segment Average Annual Daily Traffic (AADT),
- L= Length of roadway section.

Intersection accident rates are calculated with the following formula:

$$R = \frac{1{,}000{,}000 \times A}{365 \times N \times V} \quad \text{(Eq. 2)}$$

The variables in this equation are:

- R= Accident rate for the intersection expressed as accidents per million entering vehicles (MEV),
- A= Frequency of accidents in the study period,
- N= Number of years of data,
- V= Traffic volumes entering the intersection daily, usually ½ of the sum of the Average Annual Daily Traffic (AADT) volumes on the intersection's legs for two way approaches, or the sum of entering AADT volumes on one-way approaches.

Rate analysis is especially useful when there is a population of facilities to which we can compare the study area. DOT/PF has developed populations for segments and intersections, and provided this data to us. However, by only comparing the rate of the facility under analysis to an average, we may erroneously infer that those facilities with higher than average rates are problem areas.

Instead we would like to establish an upper limit for the rate that is our threshold of concern. The Rate Quality Control Method establishes an upper control limit (UCL) to determine if the facility's accident rate, as calculated in Equations 1or 2, is significantly higher than accident rates in facilities with similar characteristics. The UCL is determined statistically as a function of the statewide average accident rate for the facility category (i.e., highway or intersection) and the vehicle exposure at the location being considered. UCL is calculated with the following equation:

$$UCL = Ra + Z \times \sqrt{\frac{Ra}{M}} + \frac{1}{2 \times M}, \quad \text{(Eq. 3)}$$

The variables in this equation are:

- Ra= Average Accident Rate for the population in accidents per MEV or accidents per MVM;
- M= Facility Exposure in MEV for the intersections or MVM for roadway section**;**
- Z= Normal Distribution Transformation Variable, in this case Z = 1.28 for 90% UCL, single tail. We're say that we're 90% sure an accident rate above this level is because the intersection or segment is truly a problem and not due to chance. Using a higher UCL might eliminate some accident areas that we shouldn't overlook, and using a low UCL would cause us to examine some intersections where randomness is more of a factor and there are no real underlying causes or contributing factors.

The following Tables 3 and 4 show the intersection and segment accident types, rates, and average population rates. We also indicate where the Upper Control limit is exceeded.

Conflict Study Appendix

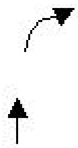
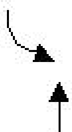
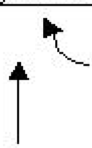
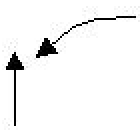
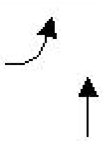
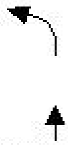
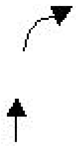
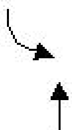
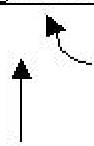
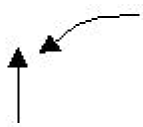
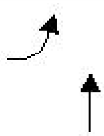
Diagram	Frequency	Conflict /Hour	Significant?	Comments
 Left Turn Same Direction	4	2	No	
 Rt Turn Same Direction	40	20	Yes	Predominately Northbound into UAS Entrance
 Slow Vehicle Same	7	4	No	
 Opposing Left Turn	0	0	No	
 Rt Turn Cross from Rt	2	1	No	
 Lt Turn Cross From Right	1	1	No	
 Lt Turn Cross from Lt	3	2	No	

Diagram	Frequency	Conflict /Hour	Significant?	Comments
 Left Turn Same Direction	7	4	No	
 Rt Turn Same Direction	71	36	Yes	Predominately Northbound into UAS Entrance
 Slow Vehicle Same	6	3	No	
 Opposing Left Turn	2	1	No	
 Rt Turn Cross from Rt	2	1	No	
 Lt Turn Cross From Right	4	2	No	
 Lt Turn Cross from Lt	8	4	No	

The tables demonstrate that the high-volume of right-turns into the UAS entrance have an expected high number of conflicts. Although this normally is not an issue, the high approach speeds may warrant a right-turn lane to eliminate the conflict.

Appendix E. Geometric Analysis

Auke Bay Corridor Study
Geometric Analysis
February 18, 2003

USKH, Inc.

Geometric Analysis

The purpose of this analysis is to evaluate the geometric conditions on Glacier Highway and Mendenhall (Back) Loop Road within the project limits. The analysis will determine if each element meets current design criteria and standards. We considered the following geometric elements:

- Horizontal Curve Radii
- Vertical Grades and Curves
- Cross Section/Clear Zone
- Intersection Sight Distance/Layout

We established design criteria earlier in the study using DOT&PF's *Highway Preconstruction Manual* and the American Association of State Highway and Transportation Officials (AASHTO) *A Policy on Geometric Design of Highways and Streets, Fourth Edition* (2001) as references. Design criteria sheets for the urban (40 MPH – Fritz Cove Road to Waydelich Creek) and rural (50 MPH – Waydelich Creek to the AMHS Terminal) portions of the corridor are appended to this memo. We based our analysis on as-built plans and topographic surveys provided by DOT&PF and on visual observations and measurements we made in the field. Designers should confirm locations and dimensions of geometric elements if a construction alternative is advanced to the design stage.

Horizontal Curve Radii

Safe and continuous operation on curvilinear highway alignments requires proper use and placement of horizontal curves. Design standards dictate appropriate curve radii based on the speed drivers are likely to observe on a given roadway segment and the superelevation used to counteract lateral acceleration, or centripetal force. We evaluated the horizontal alignment against the posted speeds and the project design criteria.

Four horizontal curves on Glacier Highway have radii that are less than the minimum radii for both the posted and design speeds – (1) near the NMFS Auke Bay Lab, (2) at the intersection with Back Loop Road, (3) near the Auke Bay post office, and (4) at Stabler's Point.

Figure 1 - Fish lab curve looking toward Auke Bay

Figure 2 - Fish lab curve looking toward Juneau

The curve near the Auke Bay Lab has a tight radius with lead-in transition, or spiral, curves. Transition curves were often used to introduce a circular curve in a natural manner. A spiral curve has a constantly changing radius and approximates the path of a vehicle entering a circular curve, gradually introducing the lateral acceleration associated with changes in the highway alignment. DOT&PF does not use spiral curves in the design of new highway construction and current practice is to replace spiral curves on reconstruction projects.

A few characteristics of this particular curve make it unusual. The entrance and exit spiral curve length are unequal and are longer than typically used at the time the roadway was originally designed. At current design standards the circular curve radius yields an operating speed of 33 mph in an area where the 85th percentile speed is about 49 mph. Also, during a past reconstruction project, the superelevation was flattened to 4 percent. The original design likely called for 8 to 10 percent superelevation and current standards for this type of road recommend 6 percent. These characteristics contribute to the discomfort experienced by drivers on this curve.

The curve at Back Loop Road is also a spiral curve, but is part of a compound curve which drivers do not usually expect. It appears that a reconstruction project flattened a portion of this curve. The substandard curve near the post office includes spirals. Two curves just before Wadelich Creek have more than adequate radii, but are reversing curves, which is a condition that drivers do not expect. These curves are in an area of slower traffic speeds.

The last substandard curve, at Stabler's Point, is part of a series of three curves that are located in a speed zone change area. All three curves have spiral transitions, and although the curves are not reversing, tangent lengths between the curves are shorter than drivers may expect.

Vertical Grades and Curves

Vertical alignment is a function of the topography a highway traverses. Steep grades affect the performance of vehicles and the comfort of non-motorized users. Vertical curves transition between grades in opposite directions and provide the required sight distance along the highway. Vertical grades and curves throughout the project area meet or exceed standards.

Cross Section/Clear Zone

The cross section refers to lane, shoulder and sidewalk widths, curbs, ditches and cut or fill slopes. The clear zone is the traversable area beyond the travel way that allows drivers of errant vehicles some recovery room. The pavement width throughout the corridor is typically 40.5 feet wide. The pavement widens to 52 feet near the AMHS terminal to allow a center turn lane. Glacier Highway and Mendenhall Loop Road have 8-foot shoulders on both sides of the road. The operating width on the shoulders meets standards for bicyclists. A 5.5-foot sidewalk runs on the right side of the road (facing outbound) from the UAS south entrance to Seaview Drive. There is a short stretch of sidewalk on the left side in front of the DeHart's parking lot.

Clear zones appear to be generally adequate, with guardrail in areas of steeper side slopes. The guardrail is damaged in many areas and guardrail end treatments do not meet current standards between Fritz Cove Road and Wadelich Creek. The height of guardrail above the roadway appears to be substandard in many areas along this same segment.

Figure 3 - Pedestrians on one side, sidewalk on other

Intersection Sight Distance/Layout

Sight distance and intersection control are factors that affect conflicts at intersections. All intersections with Glacier Highway are stop-controlled on the side street. Except the Glacier Highway intersection, all intersections with Back Loop Road are stop-controlled on the side street. We measured sight distance at all public street and commercial driveway intersections. All intersections meet the minimum standards for sight distance, but several intersections provide less than desirable standards.

Residents report Fritz Cove Road as an intersection with sight distance concerns, especially the inbound traffic on Glacier Highway. The guardrail, or seasonal brush growth, may contribute to feelings of discomfort at this location. We also observed potential sight distance problems at the DeHart's exit. Vehicles parking next to the DeHart's building and in parking spaces along the road can severely restrict sight distance in the direction of inbound traffic.

The Back Loop Road intersection with Glacier Highway has a less than desirable layout. Skew angles on both right and left turn lanes impact the driver's ability to take full advantage of the available sight distance. Auke Nu Drive also has an undesirable skew angle. The ideal intersection layout is to have the minor streets intersect at 90 degree angles.

Figure 4 - Fritz Cove Road – inbound traffic

Figure 5 - DeHart's Exit – inbound traffic

GLACIER HIGHWAY

HORIZONTAL CURVES

As-Built Sheet #	PS or PC sta.	PSC	PCS	PT Sta. End	Degree of Curvature	Direction of Curve	Radius (ft)	Length (ft)	Superelevation (%)	Max. Oper. Speed (MPH)	Posted Speed	Design Speed	Operating < Posted	Operating < Design
16	83+94.71	86+94.71	91+55.85	94+55.85	-7.7	Lt	749.5	461.14	4.0%	46	40		No	No
17	97+72.05	100+72.05	105+02.05	110+02.05	14.9	Rt	386.9	430.00	4.0%	33	40		Yes	Yes
17	**110+02.05**			**138+66.31**	**station equation**									
18	145+42.2	146+42.2		148+84.7	-4.0	Lt	1432.4	242.50	4.0%	64	35		No	No
18	148+84.7		150+01.9	152+01.9	-20.0	Lt	286.5	117.20	6.0%	30	35	**40**	Yes	Yes
19	**152+01.9**			**152+10.65**	**station equation**									
19	156+08.01	159+08.01	159+52.74	162+52.74	-15.0	Lt	383.1	44.73	6.0%	35	35		Yes	Yes
20	166+18.88			168+19.18	-7.0	Lt	819.0	200.30	6.0%	51	35		No	No
20	172+08.62			176+55.84	4.2	Rt	1370.0	447.22	6.0%	66	35		No	No
21	176+55.84			180+48.87	-7.0	Lt	819.0	393.03	6.0%	51	35		No	No
22	187+77.43	189+77.43	195+19.6	197+19.6	6.0	Rt	955.4	542.17	6.0%	55	35		No	No
22	197+69.17	199+19.17	202+49.04	203+99.04	-10.0	Lt	573.7	329.87	use 6%	43	45		Yes	Yes
	204+93.62			209+39.33	1.8	Rt	3246.8	445.71	use 6%	101	45		No	No
	212+24.2			217+22.77	-4.0	Lt	1450.1	498.57	use 6%	68	45	**50**	No	No
8	225+16.88			227+79.08	3.8	Rt	1519.3	262.20	4.0%	66	50		No	No
9	232+62.73			237+73.26	-2.3	Lt	2549.1	510.53	4.0%	85	50		No	No
10	239+36.63			242+42.79	3.0	Rt	1919.7	306.16	4.0%	74	50		No	No

GLACIER HIGHWAY

VERTICAL CURVES

52+00.00		0.00	NA	4.850%	
53+00.00		0.00	4.850%	4.990%	0.14
54+00.00		0.00	4.990%	4.240%	0.75
55+25.00		0.00	4.624%	5.185%	0.56
56+22.07	59+03.93	281.86	5.185%	2.780%	2.41
59+03.93		0.00	2.780%	3.210%	0.43
59+03.93	65+98.07	694.14	3.210%	-2.541%	5.75
65+98.07		0.00	-2.541%	-1.899%	0.64
65+98.07	69+69.93	371.86	-1.899%	-5.291%	3.39
70+25.00		0.00	-5.291%	-5.280%	0.01
72+25.00		0.00	-5.280%	-5.650%	0.37
73+25.00		0.00	-5.650%	-5.451%	0.20
73+42.55	76+53.45	310.90	-5.451%	-1.819%	3.63
77+25.00		0.00	-1.819%	-1.612%	0.21
76+01.27	79+95.00	393.73	-1.612%	1.219%	2.83
80+50.00		0.00	1.219%	1.200%	0.02
81+75.00		0.00	1.200%	1.184%	0.02
83+00.00		0.00	1.184%	1.300%	0.12
84+00.00		0.00	1.300%	1.144%	0.16
85+75.00		0.00	1.144%	1.030%	0.11
89+96.00	94+52.00	456.00	1.030%	-3.023%	4.05
97+66.00	101+44.00	378.00	-3.023%	-0.190%	2.83
139+40.00	144+84.00	544.00	-0.190%	-3.420%	3.23
145+86.00	148+86.00	300.00	-3.420%	-0.581%	2.84
155+45.00	160+19.00	474.00	-0.581%	0.850%	1.43
166+05.00	169+05.00	300.00	0.850%	4.060%	3.21
171+25.00	176+25.00	500.00	4.060%	-0.660%	4.72
185+50.00	188+26.00	276.00	-0.660%	0.260%	0.92
195+54.00	199+14.00	360.00	0.260%	-4.160%	4.42

Intersection with Glacier Hwy.	looking inbound (feet)	looking outbound (feet)	Speed Limit (MPH)	Desirable Sight Distance (feet)	Minimum Sight Distance (feet)
Fritz Cove Road	420	380	40	750	275
UAS Entrance	650	420	40	750	275
Fish Lab	375	450	40	750	275
Harbor Road	750	285	35	580	225
Deharts Exit	700	385	35	580	225
Back Loop to Inbound GH	900	850	35	580	225
Back Loop to Outbound GH	900	850	35	580	225
Auke Bay School Entrance	805	450	35	580	225
Baywiew Street	650	800	35	580	225
Seaview Street	900	570	35	580	225
Condos near Waydellich	950	350	35	580	225
Auke Nu	900	750	45	950	325
Spartan Dr.	420	650	45	950	325
On the right after Spartan	580	950	45	950	325
with Back Loop Rd.					
Caroline Street	400	550	35	580	225
UAS North Entrance	400	700	35	580	225

Posted Speed Limits

From	To	Speed
BOP	Auke Bay Harbor Rd.	40 MPH
Auke Bay Harbor Rd.	Waydelich Creek	35 MPH
Waydelich Creek	Allen Marine	45 MPH
Allen Marine	EOP	50 MPH

Note: Advisory plates for curves and pedestrian crossings exist

SI Stationing

Glacier Hwy	Fritz Cove Rd	89+66.
Glacier Hwy	Harbor Rd	148+24.
Glacier Hwy	Back Loop Rd	151+09.